(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 542 548 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
26.04.2000 Bulletin 2000/17

(51) Int. Cl.[7]: **G03B 21/62**

(21) Application number: **92310346.9**

(22) Date of filing: **12.11.1992**

(54) Transmission type screen and method of manufacturing thereof

Transparenter Projektionsschirm und Verfahren zu seiner Herstellung

Ecran de projection transparent et son procédé de fabrication

(84) Designated Contracting States:
DE FR GB NL

(30) Priority: **15.11.1991 JP 30059291**
15.11.1991 JP 30059591
15.11.1991 JP 30060591

(43) Date of publication of application:
19.05.1993 Bulletin 1993/20

(60) Divisional application:
97116627.7 / 0 819 975
97116626.9 / 0 819 974
97116625.1 / 0 816 910

(73) Proprietors:
- **MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.**
  Kadoma-shi, Osaka-fu, 571 (JP)
- **Kuraray Co., Ltd.**
  Kurashiki-shi Okayama-ken 710-0801 (JP)

(72) Inventors:
- **Mitani, Katsuaki**
  Ibaraki-shi (JP)
- **Yasumatsuya, Noboru**
  Katano-shi (JP)
- **Matsuzaki, Ichiro**
  Kitakanbara-gun, Niigata-ken (JP)
- **Kuwada, Hiroshi**
  Kitakanbara-gun, Niigata-ken (JP)

(74) Representative:
Wilson, Peter et al
Fitzpatricks,
Cardinal Court,
23 Thomas More Street
London E1W 1XU (GB)

(56) References cited:
EP-A- 0 281 690

- **PATENT ABSTRACTS OF JAPAN vol. 15, no. 180 (P-1199)9 May 1991 & JP-A-03 039 944 (HITACHI) 20 February 1991**

<u>Remarks:</u>
Divisional application 97116625.1 filed on 24/09/97.

EP 0 542 548 B1

Description

[0001] The present invention relates to a transmission type screen adapted for use as a projection type television receiver, and also relates to a method of manufacturing thereof. In particular, the present invention relates to a transmission type screen whose contrast is not substantially lowered even under external light illumination.

[0002] As shown in Fig. 12A, a transmission type screen having an arrangement of a lenticular lens sheet 48 superposed on a front surface of a Fresnel lens 45 has been conventionally used.

[0003] Further, the lenticular lens sheet 48 is made of a base material having mixed therein a light dispersing material such as glass or polymeric materials, and is formed at its two surfaces with cylindrical lenticular lenses 2, 5. Further, non-light converging parts of the light emission side lenticular lens 5 are formed respectively thereon with protrusive light absorbing layers 3 (which will be hereinbelow denoted as "black strips") at predetermined pitches in order to prevent the contrast of the transmission screen from being lowered by external light.

[0004] However, in general, the above-mentioned conventional lenticular lens sheet 48 is mingled therein with light dispersing material 4 such as glass beads or polymeric beads which are projected in part from the outer surfaces of the cylindrical lenses 5 and the black stripes 3 defined by the protrusive non-light converging parts, as shown in Fig. 12B, in order to focus an image and to enlarge the vertical viewing angle range.

[0005] Further, slight concavities and convexities are formed on the outer surface of a die for forming the surface of the lenticular lens sheet which is nearest to the viewer. These concavities and convexities are transferred to the outer surface of the lenticular lens sheet during molding so as to form an irregular reflection surface thereon in order to prevent objects surrounding the screen from being reflected therein.

[0006] Accordingly, when the external light is irradiated onto the light emission side surface of the lenticular lens sheet 48, irregular reflection occurs causing the screen surface to be whitish and the contrast to be deteriorated. Further, in order to improve the contrast of the screen even under irradiation of the external light, a mirror surface plate made of glass or transparent plastic which lowers the light transmissivity is attached to the front surface of the screen. However, this further causes external light (from fluorescent lamps, incandescent lamps, surrounding persons, windows or the like) to be highly reflected in the screen, and accordingly, the visibility of an image thereon is lowered.

[0007] The present invention is devised in order to solve the above-mentioned problems inherent in the conventional transmission type screen, and accordingly, an object of the present invention is defined in claim 1 and provides a transmission type screen including a lenticular lens sheet having a mirror-like lens surface which can prevent irregular reflection by external light so as to prevent lowering of the contrast of the screen within a suitable viewing angle range and to prevent reflection of external light. Further, another object of the present invention is defined in claim 2 and provides a method of manufacturing the transmission type screen as mentioned above.

[0008] Lenticular lens sheets used in the transmission type screen according to the present invention have the lens surface nearest to the viewer, which verges on a mirror surface as far as possible. Further, throughout the explanation which will be made hereinbelow, a double sheet-type transmission screen having a Fresnel lens sheet and a lenticular lens sheet which is composed of incident side lenses, emission side lenses formed in parts where light is converged by the incident side lenses, and light absorbing layers formed in parts where no light is converged, will be mainly concerned. However, it is noted that similar technical effects and advantages to that obtained by this transmission screen can be obtained alternatively by a double sheet type transmission screen including a lenticular lens sheet having no lenses on the incident side thereof, or a single sheet type transmission screen having a Fresnel lens formed on the rear surface thereof and lenticular lenses formed on the viewer side thereof.

[0009] It is noted that light dispersing micro particles contained in a lenticular sheet are slightly projected from the surface of the lenticular lens sheet in the case of forming the transmission type screen with the use of an extrusion molding process, and accordingly the viewer side lens surface cannot be made to be mirror-surface-like completely. Thus, it is impossible to completely eliminate irregular reflection of external light.

[0010] Therefore, according to the first aspect of the present invention, there is provided a double layer type lenticular lens sheet composed of a surface layer which does not contain light dispersing fine particles and a base layer containing the light dispersing fine particles. With this arrangement in which the surface layer conceals the light dispersing fine particles which would project slightly from the emission side lens surface of the lenticular lens as is mentioned above, it is possible to form an emission side lens surface which is completely mirror-like.

[0011] Further, according to the second aspect of the present invention, there is provided an extrusion machine for molding the lenticular lens sheet having the above-mentioned configuration. The roll die for forming the emission side lenticular lenses is processed similar to the following, that is, the roll die for forming the emission side lenses has a surface which is not formed thereon with slight concavities and convexities formed by a blast process or the like, but has a surface which is obtained directly by cutting with the use of a cutting tool. Accordingly, the surface of the lenticular sheet formed by this roll die can be substantially regarded as a mirror-surface.

[0012] Moreover, when the lenticular lens sheet has a visible light absorbing material contained in the layer which is nearest to the viewer, the light absorptance in a visible light wavelength range is increased so as to improve the con-

trast with respect to external light. In this arrangement, coloring matter, pigment, carbon, metal salt or the like which has a compatibility with thermo-plastic resin can be used as a material for absorbing visible light.

[0013] Further, the absorption spectrum of the material for absorbing visible light has not to be always flat, and further, there may be presented any wavelength characteristic, peak in order to enhance the intensity ratios of three color CRTs used in a projection type television, receiver, the color purity or the like.

[0014] The outer surface of the light absorbing layer formed on the light emission side of the lenticular lens sheet is made to be mirror-surface-like as possible as it can so as to prevent reflection of external light from entering into a suitable viewing angle range, thereby it is possible to improve the contrast with respect to the external light.

[0015] With this arrangement, according to the present invention, a lenticular lens having a simple and cheap configuration, for a transmission type screen, which can enhance the contrast with respect to external light, can be provided.

[0016] In addition to the above-mentioned features, technical effects and advantages, other features, technical effects and advantages of the present invention may be understood from the following description which will be made with reference to the accompanying drawings in which:

Figs. 1A to 1C are views illustrating a part of a first embodiment of a transmission type screen, in which Fig. 1A is a cross-sectional view, Fig. 1B is a front view and Fig. 1C is a transverse sectional view;
Fig. 2 is a graph showing wavelength characteristics obtained by the configurations of first and second embodiments of the present invention in which a visible light absorbing material is mingled.
Fig. 3 is a graph showing relative whiteness degrees of the configurations of the first and second embodiments of the present invention;
Fig. 4 is a graph showing relationships between brightness and beam currents of red, green and blue color CRTS;
Fig. 5 is a graph showing current ratios of red, green and blue color CRTs in the embodiments of the present invention and the conventional example;
Fig. 6 is a graph showing wavelength characteristics of a lenticular lens in the second embodiment of the present invention;
Fig. 7 is a schematic side view illustrating an example of installation of a projection type television receiver;
Fig. 8 is a schematic view illustrating a method of measuring the intensity of reflection with respect to an incident angle of external light;
Fig. 9 is a graph showing results in a measurement of the intensity of reflection with respect to the incident angle of external light with the use of a conventional projection type television receiver;
Fig. 10A to 10C are views illustrating a part of another embodiment of a transmission type screen, in which Fig. 10A is a cross-sectional view, Fig. 10B is a front view and Fig. 10C is a transverse sectional view;
Fig. 11 is a schematic view illustrating an apparatus for producing lenticular lens sheets in the first to third embodiments; and
Figs. 12A to 12B are views illustrating a conventional lens sheet, in which Fig. 12A is a perspective view, and Fig. 12B is a partial sectional view.

First Embodiment

[0017] Referring to Figs. 1A to 1C which show a first embodiment of a transmission type screen, the transmission type screen is a double sheet type in which a Fresnel lens sheet 26 is arranged on the light incidence side upon which output light 27 from a cathode-ray tube is incident, and a lenticular lens sheet 1 is arranged on the light emission side (or viewer side).

[0018] The lenticular lens sheet 1 is formed in one of its principal planes at an incident side thereof with lenticular lenses 5 and at an emission side one thereof with lenticular lenses 2 that are located in parts to which light is converged by the incident side lenticular lenses 5, and with black stripes 3 having equal pitches, that are located in parts where no light is converged by the incident side lenticular lenses 5. Further, the lenticular lens sheet 1 comprises two layers, that is, a surface layer 1a which is nearest to the viewer and which does not contain a light dispersing material, and a base layer 1b which contains a light dispersing material 4. Further, the surface layer 1a which is nearest to the viewer and which does not contain the light dispersing material contains a visible light absorbing material (which is not shown in the drawings). This visible light absorbing material absorbs external light so as to enhance the contrast with respect to external light.

[0019] The external light contrast ratio (1C) of the lenticular lens sheet 1, in which 30% of visible light absorbing material is mingled into the surface layer 1a so that a substantially uniform visible light transmissivity 9, which is substantially uniform although it is not actually flat in the visible light wavelength range (that is, the range from 400 to 700 nm), can be obtained, is given as 1C in Table 1, with respect to the transmissivity of a conventional transmission type screen which is 100 as shown in Fig. 2.

Table 1

External Light x Time (Screen Surface)	Contrast Ratio		Screen Brightness	
	Measured	Effect	All White	Effect
Convent. Expl. (48C)	1 : 22.4	100%	210 nlt	100%
First Embodi. (1C)	1 : 28.9	129%	148 nlt	70%
Second Embodi. (5C)	1 : 28.3	131%	170 nlt	81%

[0020] The lenticular lens sheet 1 which contains the visible light absorbing material, according to the present invention can enhance its external contrast ratio (1C) by 29% as understood from Table 1, but it lowers the brightness by 30% in comparison with the external light contrast ratio (48C) of the conventional lenticular lens sheet 48 which does not contain the light absorbing material. The above-mentioned results are caused by the inclusion of 30% of the visible light absorbing material. If the content rate of the visible light absorbing material were increased, the external light contrast would be enhanced. However, an increase in the content rate of the visible light absorbing material incurs lowering of the brightness. Accordingly, it is desirable to select a content rate of the visible light absorbing material which can improve the contrast of the article while maintaining a brightness which is minimum but actually necessary for the article.

[0021] Although the visible light absorbing material is mingled in the surface layer 1a which is nearest to the viewer and which does not contain the light dispersing material in this embodiment, it goes without saying that the visible absorbing material can be mingled into the base layer 1b which contains the light dispersing material or into the light dispersing material 4 itself, and further, the visible light absorbing material can be also mingled into the two layers, that is, the surface layer 1a and the base layer 1b, and into both of these two layers and the light dispersing material itself, thereby obtaining a similar technical effects and advantages.

Second Embodiment

[0022] Next, explanation will be made of a second embodiment of a transmission type screen with reference to Figs. 2 to 6.

[0023] In the first embodiment, the external light contrast can be enhanced, but the brightness is largely lowered. In this embodiment, the wavelength absorptivity in the visible light range is made to be selective in order to restrict lowering of the brightness.

[0024] This embodiment includes the feature that a visible light absorbing material having a selective wavelength characteristic by which the absorptivities with respect to red and green light are high but the absorptivity with respect to blue light is low, is mingled. As shown in Fig. 2, with respect to the absorptivity of the conventional transmission screen which is 100, a selective wavelength absorbing material having an absorptivity which is low (about 17% around 450 nm) in a wavelength range less than 490 nm within the visible wavelength range (that is, 400 to 700 nm), and which is high (about 40 to 45% in a range from 520 to 660 nm) in a wavelength range from 400 to 700 nm is mingled, as the light absorbing material, in the surface layer 1a which is nearest to the viewer and which does not contain the visible light dispersing material, and accordingly, 30% of absorptivity which is substantially equal to that in the first embodiment can be obtained, on a whole average.

[0025] In the case of a projection type television receiver using blue, green and red color cathode ray tubes (which will be hereinbelow denoted simply as "CRTs"), in general, the CRTs exhibit light emitting spectra as shown in Fig. 2 at a color fluorescent surface formed on the display panel section, that is, the blue color CRT gives a light emitting spectrum as indicated by 11 having a main peak around a wavelength of 450 nm, the green color CRT gives a light emitting spectrum as indicated by 12 and having a main peak around a wavelength of 550 nm, and the red color CRT gives a light emitting spectrum as indicated by 13 and having a peak around the wavelength of 610 nm.

[0026] The selective wavelength absorptivity 10 in this embodiment is approximated to 30% of absorptivity which is equal to the uniform absorptivity in the first embodiment, as shown in Fig. 2. This fact will be explained by way of comparison. In the case of setting a white color at a certain color temperature (for example, 9,000 deg.K), the brightness ratios of red, green and blue as indicated by 14, 15, 16 in Fig. 3 are required for a conventional transmission type screen although certain differences in adjustment are present dependent on the kind of projection type television receiver to be used. Further, since the brightness ratios on the screen surface are equal to those on the CRT surfaces, they can be derived from the relationships between the CRT beam currents which are measured under a predetermined condition

shown in Fig. 4, and the brightness on the CRT surfaces, and accordingly, the maximum brightness can be obtained when the maximum rated currents of the CRTS are identical, that is, when the beam current running through the blue CRT reaches a maximum rated value. Thus, with the use of this value as a reference, the red and green beam currents are adjusted so as to set a white color at a certain color temperature (for example, 9,000 deg.K), and accordingly, the current ratios of red, green and blue colors as indicated by 20 in Fig. 5 are obtained (although difference in adjustment is present dependent on the kind of projection type television receiver to be used). The reason why the color ratio of the blue color CRT is large, is that the efficiency of light emission on the blue color CRT surface as indicated by 19 in Fig. 4 is lower than those on the green and red color CRT surfaces as indicated by 17, 18.

[0027] If the light absorbing material having a uniform absorptivity with respect to light in a visible light range as exhibited by the wavelength characteristic 9 shown in Fig. 2, is used, the current ratios are given by 21 in Fig. 5 when a white color at the same color temperature (for example, 9,000 deg.K) is set. That is, the current ratios are substantially equal to those of the conventional transmission type screen. The brightness ratios of red, green and blue at the screen are given by 15 shown in Fig. 3, that is, the brightness are lowered by degrees corresponding to the visible light absorptivity of the screen.

[0028] As a wavelength characteristic 10 shown in Fig. 2, in such a case that the absorptivity in the wavelength range of the light emitting spectrum 11 of the blue color CRT is low, but the absorptivities in the wavelength ranges of the light emitting spectrums 12, 13 of the red and green color CRTs are high, if beam currents having the same power allocation as that of a conventional one are fed to the blue, green and red color CRTs, the blue color is intensified at the color temperature which is higher than 9,000 deg.K since the absorptivities of green and red colors are high but the absorptivity of blue color is low. Accordingly, in order to make adjustment for the white color at the color temperature of 9,000 deg.K as in the conventional one, the maximum rated current running through the blue color CRT is not changed so that the powers for beam currents running through the green and red color CRTs should be increased by degrees corresponding to values by which the absorptivities of the green and red colors are higher than the absorptivity of the blue color. As a result, the beam current ratios of the CRTs are given by 22 in Fig. 5. That is, in comparison with the beam ratios given by 20 and 21, the beam current ratios of the green and red color CRTs becomes higher but the beam current ratio of the blue color CRT becomes lower.

[0029] Thus, by increasing the beam current ratios of the green and red color CRTS, the brightness ratios become substantially equal to those of the red, green and blue colors in the conventional arrangement, as indicated by 16 in Fig. 3. However, since the brightness ratios of the green and red colors having high light emitting efficiencies become higher, the lowering of the brightness of the total whiteness with the use of the selective wavelength absorbing material is less than that with the use of material having an uniform absorptivity.

[0030] Further, since the external light contrast ratio varies largely, depending on intensity of the external light and a surrounding atmosphere, the results of measurements which were made at an illumination intensity of 200 Lux at the screen surface under the same atmosphere are given in Table 1. The external light contrast ratio (5C) of the second embodiment is improved by 30%, as understood from Table 1, similarly to the external contrast ratio (1C) of the first embodiment which contains the visible light absorbing material 9 having a uniform light absorptivity, in comparison with the external contrast ratio (48C) of the conventional one which does not contain the visible light absorbing material. Further, the brightness becomes higher than that of the of the first embodiment by 11% but is lower than that of the conventional one by 19%. Thus, through various studies of the absorptivities of the blue, green and red colors, a screen having an optimum contrast ratio and brightness suitable for a projection type television receiver to be used can be selected.

[0031] The above-mentioned second embodiment is one of a number of examples. The selective wavelength is controlled variously in such a condition that the absorptivity blue color light emitting spectrum range (less than 490 nm) is less than 50% while the absorptivity in the green and red color spectrum range (490 to 700 nm) is in a range of 30 to 80%, so as to obtain a desired contrast ratio and brightness. As another wavelength selecting method, the adjustment can be made dependent on the blue color light emitting spectrum range, the green color light emitting spectrum range and the red color light emitting spectrum range, as understood from characteristics 23, 24 shown in Fig. 6. In this case, it is required that selection is made in a range of less than 50% for the absorptivity in the blue color light emitting spectrum range (490 nm), in a range of 30 to 80% for the absorptivity of the green color light emitting spectrum range (490 to 580 nm) and in a range of 30 to 80% for the absorptivity in the red color light emitting spectrum range (580 to 700 nm), and it is also required that the absorptivity in the blue color light spectrum range is lower than those in the green and red color light emitting spectrum ranges.

Further Example

[0032] Explanation will be hereinbelow made of a further example not comprised within the scope of the claims of a transmission type screen with reference to Figs. 10A to 10C and Figs. 7 to 9.

[0033] Referring to Figs. 10A to 10C, a lenticular lens sheet 1 is formed at the incidence side of one its principal

planes with lenticular lenses 5 and at the emission side thereof with lenticular lenses 2 that are located in parts to which light is converged by the incident side lenticular lenses 5, and with black stripes 3 having equal pitches, that are located in parts where no light is converged by the incident side lenticular lenses 5. Further, the lenticular lens sheet 1 located on the emission side is composed of two layers, that is, a surface layer 1a which is nearest to the viewer and which does not contain a light dispersing material, and a base layer 1b which contains the light dispersing material 4. Further, the surface layer 1a which is nearest to the viewer and which does not contain the light dispersing material 4 is formed at its outer surface with mirror-surfaces 2a, 3a having a luster thereon, which prevent occurrence of irregular reflection of external light.

[0034] The reflection includes normal reflection and irregular reflection. In the case of reflection on a mirror-surface, normal reflection mainly occurs, but in the case of reflection on a surface which is formed with fine convexities and concavities, irregular reflection mainly occurs. The lenticular lens 1 having the emission side surface which is mirror-like, mainly causes normal reflection, that is, the incidence angle of light is equal to the reflection angle. In the case of incidence light rays 6a, 6b as shown in Fig. 1C, reflection light rays 7a, 7b, 7a", 7b" are obtained. On the contrary, the reflection surface which is formed with fine concavities and convexities as shown in Fig. 12B, causes irregular reflection. That is, the incidence angle of light incident upon the reflection surface differs depending on the shape of the surface, and reflection occurs at a reflection angle having a value equal to that incidence angle. Accordingly, the incidence angle of external light rays 46a, 46B are turned into reflection light rays 47a, 47b which enter into suitable viewing angle range, causing the contrast to be lowered.

[0035] Next explanation will be qualitatively made of the reason why a difference occurs in the contrast in the case of a projection type television receiver which is set in a room.

[0036] The projection type television receiver is in general set as shown in Fig. 7, and in this case, the practical viewing angle range 25 is defined between the floor on which the viewer lies and the height of the viewer who stands on the floor, at a position distant from the screen of the television receiver by 2 m. In this case, light from lamps 28, 29, 30 at the ceiling cause normal reflection, if the screen surface is mirror-like, so that the light comes to positions 32, 33, 34, 35 on the floor. That is, only irregular reflection enters into the practical viewing angle range 25. Since the height H of the center of the screen 37 of the projection type television screen is usually about 1 m, normal reflection entering into the practical viewing angle range 25 occurs when external light has an incidence angle θ which is about 26.5 deg. That is obtained from Equation (1) as follows, estimating that the distance between the screen of the television and the viewer is 2 m:

$$\tan\theta = \frac{L}{H} \tag{1}$$

where L is distance between the screen and the viewer and H is the height of the center of the screen.

[0037] Since the incidence angle is equal to the reflection angle, the viewer notices a lowering of the contrast at an incidence angle of about 26.5 deg. only when he watches the television lying on the floor. However, no reflection of the external light reaches the viewer if he watches the television with a sitting or standing posture, and accordingly, he does not notice a lowering of the contrast. In general, the incidence angle of light from a lamp at the ceiling, a fluorescent lamp or an incandescent lamp suspended from the ceiling as a light source will rarely be below 26.5 deg., except in extraordinary cases.

[0038] Further, external light entering from outside through a window includes not only parallel light but largely includes oblique light and accordingly, no problem occurs unless sunlight is directly incident upon the screen surface of the television receiver set by a window. The external light is irregular so that it is incident upo the screen surface at various angles, depending upon a position of the light source.

[0039] Next, the light dispersion characteristics and contrast data of the conventional lenticular sheet having a surface formed thereon with concavities and convexities, and the lens sheet having a mirror surface according to the present invention will be given, and further explanation thereto will be made.

[0040] Fig. 8 is a plan view for explaining the way of measurement for reflection light. As shown in Fig. 8 within a dark room, light was projected from a projector as a light source through a pin hole having a bore diameter of 5 mm, and accordingly, a light beam 42 having an incidence angle at a screen 38 lined with a black sheet 39, which was slightly larger than a photometric angle 44 of a brightness meter was directed to the screen 43. By successively changing the incidence angle, normal reflection and irregular reflection were measured with the use of the brightness meter 43, and the results of the measurement are shown in Fig. 9. However, the measurement at an incidence angle of zero could not be made since the light source and the brightness meter were aligned with each other. Accordingly, the incident light at an angle of 3 deg. was measured.

[0041] Fig. 9 shows three kinds of relationships between the finished conditions of the emission side surfaces of screens and reflection light, which are plotted at every incidence angle. As a result, the incident light at an angle of 3

deg. gives reflection indicated by c and d to the viewer with the light source at an angle of 3 deg as shown in Fig. 9. The light c having a high brightness reaches the viewer watching the projection type television receiver if the mirror surface which gives largely normal reflection exhibits a curve 51. However, if the surface giving curve 49 is not mirror-like but has convexities and concavities, although an angle is near to that of normal reflection, the incident light is dispersed by convexities and concavities so that reflection becomes substantially irregular, and accordingly, reflection d having a low brightness reaches the viewer.

[0042] Further, no reflection having such an incidence angle actually occurs, or it is extremely slight although it is present. In the case of incident light having an incidence angle of larger than 15 deg., reflection reaching the viewer watching the projection type television receiver affects the contrast. Accordingly, in an incidence angle range of 15 to 60 deg., concerning the intensity of the reflection by the incident light, the reflection brightness of the above-mentioned incident light at an angle of 3 deg. is reversed, and accordingly, the reflection brightness of reflection rays f, h, j, l at the mirror surface giving the curve 51 is lower than that of reflection rays e, g, i, k at the surface formed thereon with slight concavities and convexities and giving the curve 49. Thus, the external contrast can be improved accordingly.

[0043] Next, explanation will be made of effects by improvements in contrast, according to the present invention.

[0044] As shown in Fig. 10C, light 27 projected from a CRT is transmitted through a screen composed of a Fresnel lens sheet 26 and a lenticular lens sheet 1, and is therefore turned into a transmitted light 56 having a white light intensity W and a black light intensity B. Incident light 53 given by external light is reflected by the outer surfaces 2a, and 3a of lenticular lenses 2 and black stripes 3, and the thus obtained reflected light Δx has normal reflection 54 whose intensity is highest and irregular reflection 55 whose intensity is low.

[0045] The contrast ration C(n) is given by Equation (2), and further, since the white light intensity W is higher than the black light intensity B, the relationship given by Expression 3 can be obtained.

$$C(n) = \frac{W}{B} \tag{2}$$

$$W > B \tag{3}$$

[0046] The contrast ratio C(g) with respect to the external light is given by Equation (4):

$$C(g) = \frac{W+\Delta x}{B+\Delta x} \tag{4}$$

[0047] Concerning the external light contrast ratio at a certain position (for example, at a position 56 on the screen front surface shown in Fig. 10C) in the practical viewing angle range, in the case of the emission side surface of the lenticular lens sheet according to the present invention, which is mirror-like, the reflection Δx is exhibited by a curve (c, b, h, j, i) 51 shown in Fig. 9, which is given by an entirely mirror surface, but in the case of a surface having concavities and convexities, the reflection Δx is exhibited by a curve (d, e, g, i, k) 49 as shown in Fig. 9, which is given by a concave and convex surface. The relationships given Expressions (5) and (6) are obtained.

$$\Delta x(c) > \Delta x(D) \tag{5}$$

$$\Delta X(f,h,j,l) < \Delta x(e,g,i,k) \tag{6}$$

[0048] Accordingly, from the relationship between the expressions (3) and (4), the external light contrast ratios become $C(\gamma) < C(\delta)$ where $C(\gamma)$ is contrast ratio obtained by the screen according to the present invention, and $C(\delta)$ is contrast ratio obtained by the conventional screen, if the relationship is given by Expression (5), but they become $C(\gamma) > C(\delta)$ if the relationship is given by Expression (6). In comparison between the screen according to the present invention and the conventional one, since the cross point 52 at which the relationship in intensity of reflection light is reversed is less than an incidence angle of 15 deg., and further since the practical viewing angle range 25 is below 26.5 deg. as calculated by Equation (1) in such a case that the viewer watches the projection type television receiver 36, no strong reflection can reach the viewer, substantially, and further, no reflection $\Delta x(c)$, $\Delta x(d)$ at an angle of 3 deg. as given by Expression (5) reaches the viewer, substantially. The reflection given by Expression (6) is mainly obtained.

[0049] Accordingly, in the case of the lenticular lens sheet having the emission side surface which is mirror-like, according to the present invention, the reflection does not reach the viewer, substantially, and therefore, it has been proved that the contrast with respect to external reflection can be improved. Further, measurement of the contrast ratio with respect to external light was made actually when light from the ceiling, as external light, was incident upon the

screen, as shown in Fig. 7, and the results of measurement are given in Table 2. As understood from Table 2, the screen having a surface which is entirely mirror-like, according to the present invention exhibits a contrast ratio Cd of 1 : 14.8 while the conventional one having a surface which is formed thereon with concavities and convexities exhibits a contrast ratio Ca of 1 : 12.19 with a black window pattern of 1% when the illumination intensity in a plane perpendicular to the screen is 500 Lux even although the contrast ratios thereof in a dark room are identical with each other. That is, the constrast ratio in the case of the entire mirror-like-surface can be improved by 12%.

[0050] Further, if a glass pane or plastic mirror surface plate is laid in front of the surface of the screen, an image thereon cannot be observed clearly since the screen surface reflects therein an object (a fluorescent tube, a lamp, a window, a curtain, furniture, a person or the like) around the screen although the contrast can be improved. On the contrary, with the lenticular lens sheet 1 having the emission side surface which is mirror-like according to the present invention, the reflection therein is diverged horizontally by the lenticular lens, and accordingly, the shape of the reflection therein becomes horizontally longer. Further, the reflection is slitted by the black stripes so that the reflection therein is not continuous. Thereby, it is possible to provide a high quality image having a higher contrast, a high resolution and less reflection therein.

Table 2

		CONVENTIONAL CONCAVE & CONVEX SCREEN	#6 EM (MIRROR SURFACE)	CONTAINING 30% LIGHT ABSORBING MATERIAL	
				#1 EM	COMBI #1 & #6
D	BLACK (B)	7 nit	4.46	4.47	4.46
	WHITE (W)	159 nit	159	180	160
	CONTRAST RATIO (W/B)	1:35.6	1:35.7	1:35.8	1:35.9
E	REFLECTION (ΔX) AT SCREEN	7:91 nit	7.12	5,53	4.98
	BLACK (B +ΔX)	13.0 nit	11.7	10.6	9.44
	WHITE (W + ΔX)	168 nit	168	169	169
	EXTERNAL LIGHT	Ca	Cb	Cc	Ce
	CONTRAST RATIO (W +ΔX)/(B + ΔX)	1:12.9	1:14.5	1:16.0	1:17.9
IMPROVED EFFECT IN CONTRAST IN COMPARISON TO CONVENTIONAL CONCAVE & CONVEX SCREEN		x 1	x 1.12 + 12%	x 1.24 + 24%	x 1.39 +39%

NOTE: External light is oblique light from ceiling, and is measured with illumination intensity of 500 Lux at the center of screen surface.
D: Dark Room
E: External light

[0051] Explanation will be made of a method of producing the screens in the above-mentioned first and second embodiments, according to the present invention, with reference to Fig. 11.

[0052] A lenticular lens sheet base material 61 extruded from an extruder 60 of an extrusion molding machine is led through an incidence side forming roll 62 for forming the incidence side lenticular lens surface and an emission side forming roll 63 for forming the emission side lenticular surface so as to form the lenticular lens sheet 1. At this time, a transparent resin sheet 64 which is compatible with the lenticular lens sheet base material 61 is fed to the emission side forming roll 63 for forming the emission side lenticular lenses and the black stripe surfaces so as to form the surface

layer 1a which does not contain the light dispersing material on the surface which is nearest to the viewer. In this embodiment, by using a compatible transparent resin sheet in which the visible light absorbing material is mingled, together with a lenticular lens sheet in which the light dispersing material is mingled, the transmission type screen in the first embodiment can be obtained. Further, if lenticular lens forming surfaces 2a-a and black stripe forming surfaces 3a-a on the emission side forming roll 63 are made to be mirror-like, the screen in the third embodiment can be obtained.

[0053] Explanation will now be made of another method of forming the surface layer 1a which is nearest to the viewer and which does not contain the light dispersing material. The lenticular lens sheet base material 61 is extruded from the extrusion molding machine 60 so as to produce the lenticular lens sheet 1 formed on the incidence side thereof with the lenticular lenses 5 and on the emission side thereof with the lenticular lenses 2 and the black stripes 3. Then, metal or nonmetal, metal oxide or nonmetal oxide such as MgF_2, SiO_2, is deposited on the outer surfaces of the lenticular lenses 2 and the black stripes 3 on the emission side surface or the lenticular lens sheet 1 by evaporation, sputtering or the like so as to form thin films thereon, thereby it is possible to obtain mirror-surfaces which can improve the transmissivity with less reflection.

[0054] The above-mentioned method is effective for the third embodiment. Naturally, a transparent material can be formed by coating, dipping, printing, painting or the like.

[0055] Further, there may be used a method in which a film is coated or printed thereover with a transparent material, and then the transparent material is transferred from the film by a hot stamp, a roll or the like for forming a thin film, a method in which a supply sheet is coated or printed thereover with a transparent material, and thereafter, the sheet alone is peeled therefrom, and so forth. If no visible light absorbing material is mingled in the above-mentioned transparent sheet, the screen of the further example can be manufactured. If the visible light absorbing material is mingled therein, the screens in the first and second embodiments can be formed.

Claims

1. A transmission type screen having an incident side surface upon which light from a projector is incident, and an emission side surface from which the projected light emits toward the viewer, comprising a Fresnel lens sheet (26) arranged on the side where the light from the projector is incident and a lenticular lens sheet (1) arranged on the side where said projected light emits from said emission side surface to the viewer, said lenticular lens sheet (1) comprising two layers, that is; a body layer (1b) near said incident side surface and a surface layer 1a on said emission side surface, said lenticular lens sheet (1) being formed therein with lenticular lenses (5) on the side near said incident side surface and lenticular lenses (2) alternated with portions having no light converging property (3a) on said emission side surface, said lenticular lenses (5) on said incident side surface converging projected light to said emission side surface lenticular lenses (2), (3), characterized in that said body layer (1b) contains a light dispersing material (4), said surface layer (1a) is free from light dispersing material (4), at least one of said body layer (1b), said surface layer (1a) and said dispersing material (4) contains a light absorbing material which absorbs visible light having a wavelength from 400 to 700 nm, and said emission side surface has a mirror-like surface for preventing random light reflection.

2. A method of manufacturing a transmission type screen according to claim 1, said screen having an incident side surface upon which light from a projector is incident and an emission side surface from which the projection light emits towards the viewer, the method comprising extruding a sheet of base material (61), feeding onto said sheet of base material a transparent resin sheet (64), and roll forming said base material (61) and said resin sheet (64) together to form a lenticular lens sheet (1) having an incident side surface formed in the base material and an emission side surface formed in the resin sheet, wherein said base material is formed to contain a light dispersing material, said resin sheet is free from light dispersing material, at least one of said base material, said resin sheet and said light dispersing material are formed to contain a light absorbing material, and the lenticular lens sheet (1) is formed with its emission side surface having a mirror-like surface.

3. A method as claimed in claim 2, wherein said transparent resin sheet (64) is coated with visible light absorbing material by dipping, coating, sputtering, evaporating, transferring, hot stamping, painting or the like.

4. A method of manufacturing a transmission type screen according to claim 1, said screen having an incident side surface upon which light from a projector is incident and an emission side surface from which the projection light emits towards the viewer, the method comprising extruding a sheet of base material (61) formed to contain a light dispersing material, and roll forming said base material (61) to form a lenticular lens sheet (1) having an incident side surface and an emission side surface having the shapes specified in claim 1, at least one of said base material and said light dispersing material being formed to contain a light absorbing material, wherein the lenticular lens

sheet (1) is formed with its emission side surface having a mirror-like surface, which is formed by depositing metal or nonmetal, metal oxide or nonmetal oxide such as MgF_2, or SiO_2 so as to form films thereof on said emission side surface.

Patentansprüche

1. Transparenter Projektionsschirm, welcher eine einfallsseitige Oberfläche, auf welche Licht von einem Projektor außtrifft, und eine abstrahlseitige Oberfläche besitzt, von welcher das projizierte Licht zum Betrachter abgestrahlt wird, aufweisend: eine Fresnel-Linsentafel (26), welche auf der Seite angeordnet ist, aufder das Licht vom Projektor auftrifft, und eine linsenförmige Linsentafel (1), welche auf der Seite angeordnet ist, auf welcher das projizierte Licht von der abstrahlseitigen Oberfläche zum Betrachter abgestrahlt wird, wobei die linsenförmige Linsentafel (1) zwei Schichten aufweist, und zwar eine in der Nähe der einfallsseitigen Oberfläche befindliche Körperschicht (1b) und eine auf der abstrahlseiten Oberfläche befindliche Oberflächenschicht (1a), wobei die linsenförmige Linsentafel (1) auf ihrer in der Nähe der Einfallsseite befindlichen Oberfläche mit linsenförmigen Linsen (5) und auf der abstrahlseitigen Oberfläche mit linsenförmigen Linsen (2), welche sich mit Abschnitten (3a) ohne lichtkonvergierende Eigenschaften abwechseln, ausgebildet ist, und die auf der einfallsseitigen Oberfläche befindlichen linsenförmigen Linsen (5) das projizierte Licht zu den auf der abstrahlseitigen Oberfläche befindlichen linsenförmigen Linsen (2) konvergieren, dadurch gekennzeichnet, daß die Körperschicht (1b) ein lichtstreuendes Material (4) enthält, die Oberflächenschicht (1a) frei von lichtstreuendem Material (4) ist, zumindest eines von der Körperschicht (1b), der Oberflächenschicht (1a) und dem streuenden Material (4) ein lichtabsorbierendes Material enthält, das sichtbares Licht mit einer Wellenlänge von 400-700 nm absorbiert, und die abstrahlseitige Oberfläche spiegelartig ist, um eine diffuse Lichtreflektion zu verhindern.

2. Verfahren zur Herstellung eines transparenten Projektionsschirms nach Anspruch 1, wobei der Schirm eine einfallsseitige Oberfläche, auf welche Licht von einem Projektor auftrifft, und eine abstrahlseitige Oberfläche besitzt, von welcher das projizierte Licht zum Betrachter abgestrahlt wird, und das Verfahren umfaßt: Strangpressen einer Basismaterialtafel (61), Zuführen einer transparenten Harztafel (64) auf die Basismaterialtafel und gemeinsames Formwalzen des Basismaterials (61) und der Harztafel (64), um eine linsenförmige Linsentafel (1) auszubilden, welche eine im Basismaterial ausgebildete einfallsseitige Oberfläche und eine in der Harztafel ausgebildete abstrahlseitige Oberfläche besitzt, wobei das Basismaterial so ausgebildet ist, daß es ein lichtstreuendes Material enthält, die Harztafel frei von lichtstreuendem Material ist, und mindestens eines von dem Basismaterial, der Harztafel und dem lichtstreuendem Material so ausgebildet sind, daß sie ein lichtabsorbierendes Material enthalten, und die linsenförmige Linsentafel (1) mit einer abstrahlseitigen Oberfläche mit spiegelartiger Oberfläche ausgebildet ist.

3. Verfahren nach Anspruch 2, bei welchem die transparente Harztafel (64) mit sichtbares Licht absorbierendem Material beschichtet ist, und zwar durch Eintauchen, Beschichten, Sputtern, Übertragen, Warmprägen, Bedrucken oder dergleichen.

4. Verfahren zur Herstellung eines transparenten Projektionsschirms nach Anspruch 1, wobei der Schirm eine einfallsseitige Oberfläche, auf welche Licht von einem Projektor auftrifft, und eine abstrahlseitige Oberfläche besitzt, von welcher das projizierte Licht zum Betrachter abgestrahlt wird, und das Verfahren umfaßt: Strangpressen einer Basismaterialtafel (61), welche so ausgebildet ist, daß sie ein lichtstreuendes Material enthält, und Formwalzen des Basismaterials (61), um eine linsenförmige Linsentafel (1) auszubilden, welche eine einfallsseitige Oberfläche und eine abstrahlseitige Oberfläche besitzt, deren Formen in Anspruch 1 spezifiziert sind, wobei das Basismaterial und/oder das lichtstreuende Material so ausgebildet sind, daß sie ein lichtabsorbierendes Material enthalten, und die linsenförmige Linsentafel (1) auf ihrer abstrahlseitigen Oberfläche mit spiegelartiger Oberfläche ausgebildet ist, die durch Niederschlag von Metall oder Nicht-Metall, Metalloxid oder Nicht-Metalloxid, wie etwa MgF_2, oder SiO_2, zur Ausbildung von daraus bestehenden Filmen auf der abstrahlseitigen Oberfläche ausgebildet sind.

Revendications

1. Ecran du type à transmission comportant une surface du côté d'incidence sur laquelle de la lumière provenant d'un projecteur est incidente, et une surface du côté émission à partir de laquelle la lumière projetée est émise vers l'observateur, comprenant une feuille de lentilles de Fresnel (26) disposée sur le côté sur lequel la lumière provenant du projecteur est incidente, et une feuille de lentilles lenticulaires (1) disposée sur le côté sur lequel ladite lumière projetée est émise à partir de ladite surfac du côté émission vers l'observateur, ladite feuille de lentilles lenticulaires (1) comprenant deux couches, à savoir, une couche de base (1b) près de ladite surface du côté d'inci-

dence et une couche de surface (1a) sur ladite surface du côté d'émission, ladite feuille de lentilles lenticulaires (1) étant munie, dans celle-ci, de lentilles lenticulaires (5) sur le côté proche de ladite surface du côté d'incidence et des lentilles lenticulaires (2) alternant avec des parties ne présentant pas de propriété de convergence de la lumière (3a) sur ladite surface du côté émission, lesdites lentilles lenticulaires (5) sur ladite surface du côté d'incidence faisant converger la lumière projetée vers lesdites lentilles lenticulaires de la surface du côté émission (2), caractérisé en ce que ladite couche de base (1b) contient un matériau dispersant la lumière (4), ladite couche de surface (1a) est exempte de matériau dispersant la lumière (4), au moins l'un parmi ladite couche de base (1b), ladite couche de surface (1a) et ledit matériau de dispersion (4) contient un matériau absorbant la lumière qui absorbe la lumière visible présentant une longueur d'onde entre 400 et 700 nm, et ladite surface du côté émission présente une surface analogue à un miroir destinée à empêcher une réflexion de lumière aléatoire.

2. Procédé de fabrication d'un écran du type à transmission selon la revendication 1, ledit écran comportant une surface du côté d'incidence sur laquelle de la lumière provenant d'un projecteur est incidente, ainsi qu'une surface du côté émission à partir de laquelle la lumière de projection est émise vers l'observateur, le procédé comprenant l'extrusion d'une feuille de matériau de base (61),l'alimentation jusque sur ladite feuille de matériau de base d'une feuille de résine transparente (64), et le formage par rouleaux dudit matériau de base (61) et de ladite feuille de résine (64) ensemble afin de former une feuille de lentilles lenticulaires (1) comportant une surface du côté d'incidence formée dans le matériau de base et une surface du côté d'émission formée dans la feuille de résine, dans lequel ledit matériau de base est formé de façon à contenir un matériau dispersant la lumière, ladite feuille de résine est exempte de matériau dispersant la lumière, au moins l'un parmi ledit matériau de base, ladite feuille de résine et ledit matériau dispersant la lumière est formé de façon à contenir un matériau absorbant la lumière, et la feuille de lentilles lenticulaires (1) est formée en dotant sa surface du côté d'émission d'une surface analogue à un miroir.

3. Procédé selon la revendication 2, dans lequel ladite feuille de résine transparente (64) est revêtue d'un matériau absorbant la lumière visible, par immersion, enduction, pulvérisation, évaporation, transfert, matriçage à chaud, mise en peinture ou analogue.

4. Procédé de fabrication d'un écran du type à transmission selon la revendication 1, ledit écran comportant une surface du côté d'incidence sur laquelle de la lumière provenant d'un projecteur est incidente, ainsi qu'une surface du côté d'émission à partir de laquelle la lumière de projection est émise vers l'observateur, le procédé comprenant l'extrusion d'une feuille de matériau de base (61) formée de façon à contenir un matériau dispersant la lumière, et le formage par rouleaux dudit matériau de base (61) afin de former une feuille de lentilles lenticulaires (1) présentant une surface du côté d'incidence et une surface du côté d'émission présentant les formes spécifiées dans la revendication 1, au moins l'un parmi ledit matériau de base et ledit matériau dispersant la lumière étant formé de façon à contenir un matériau absorbant la lumière, dans lequel la feuille de lentilles lenticulaires (1) est formée en dotant sa surface du côté d'émission d'une surface analogue à un miroir, qui est formée en déposant du métal, du non-métal, un oxyde métallique ou un oxyde non-métallique, tel que MgF_2, ou SiO_2, de manière à former des films à partir de celui-ci, sur ladite surface du côté d'émission.

FIG. 1A

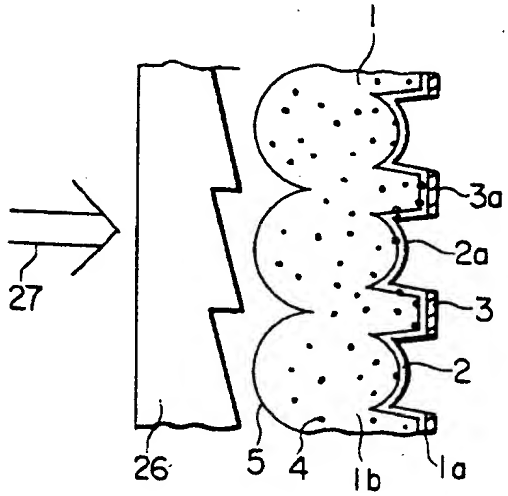

FIG. 1B

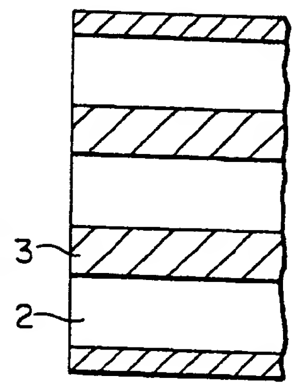

FIG. 1C

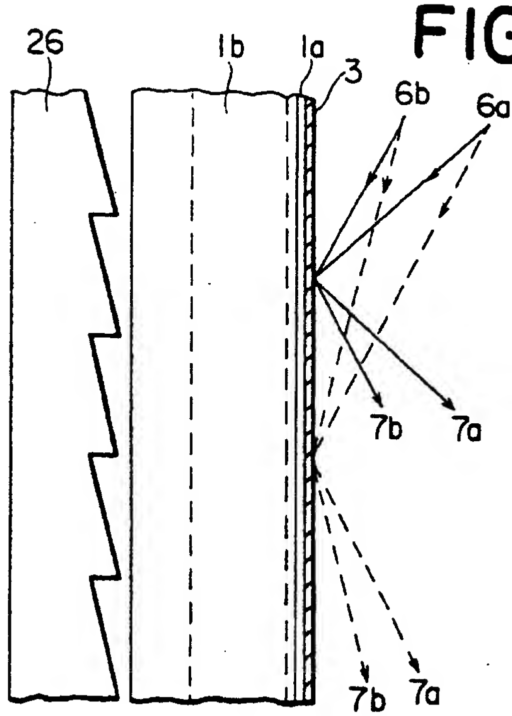

FIG. 2

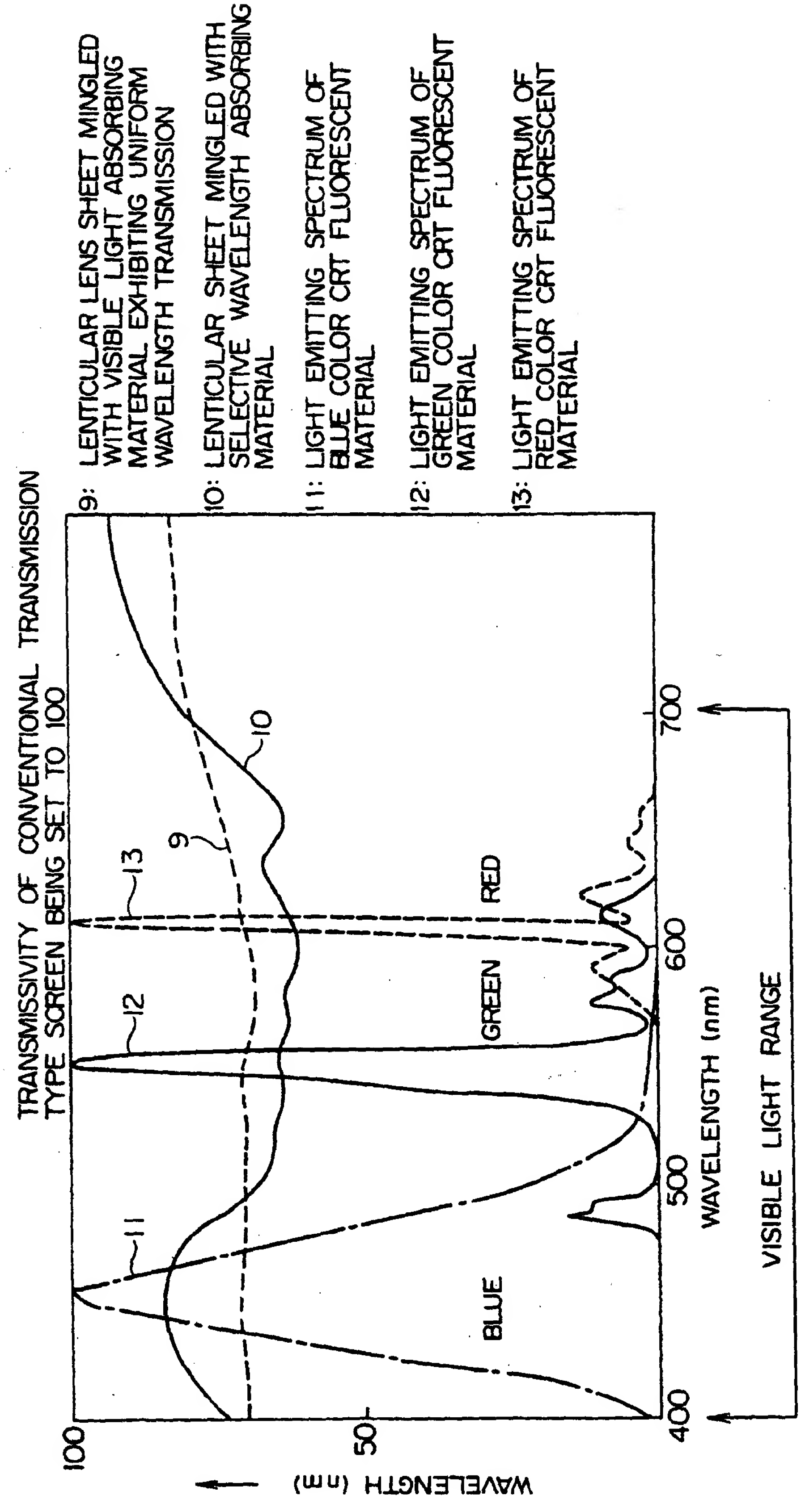
TRANSMISSIVITY OF CONVENTIONAL TRANSMISSION TYPE SCREEN BEING SET TO 100
WAVELENGTH (nm)
100
50
400
500
600
700
WAVELENGTH (nm)
VISIBLE LIGHT RANGE
BLUE
GREEN
RED
9
10
11
12
13
9: LENTICULAR LENS SHEET MINGLED WITH VISIBLE LIGHT ABSORBING MATERIAL EXHIBITING UNIFORM WAVELENGTH TRANSMISSION
10: LENTICULAR SHEET MINGLED WITH SELECTIVE WAVELENGTH ABSORBING MATERIAL
11: LIGHT EMITTING SPECTRUM OF BLUE COLOR CRT FLUORESCENT MATERIAL
12: LIGHT EMITTING SPECTRUM OF GREEN COLOR CRT FLUORESCENT MATERIAL
13: LIGHT EMITTING SPECTRUM OF RED COLOR CRT FLUORESCENT MATERIAL

FIG. 3

14: DEGREE OF BRIGHTNESS OF CONVENTIONAL TRANSMISSION TYPE SCREEN, BRIGHTNESS RATIOS OF RED, GREEN AND BLUE COLOR EXHIBITED BY CONVENTIONAL TRANSMISSION TYPE SCREEN

15: DEGREE OF BRIGHTNESS AND BRIGHTNESS RATIOS OF RED, GREEN AND BLUE COLORS CAUSED BY 30 % OF UNIFORM VISIBLE LIGHT ABSORBING MATERIAL

16: DEGREE OF BRIGHTNESS AND BRIGHTNESS RATIOS OF RED, GREEN AND BLUE COLORS CAUSED BY SELECTIVE WAVELENGTH ABSORBING MATERIAL

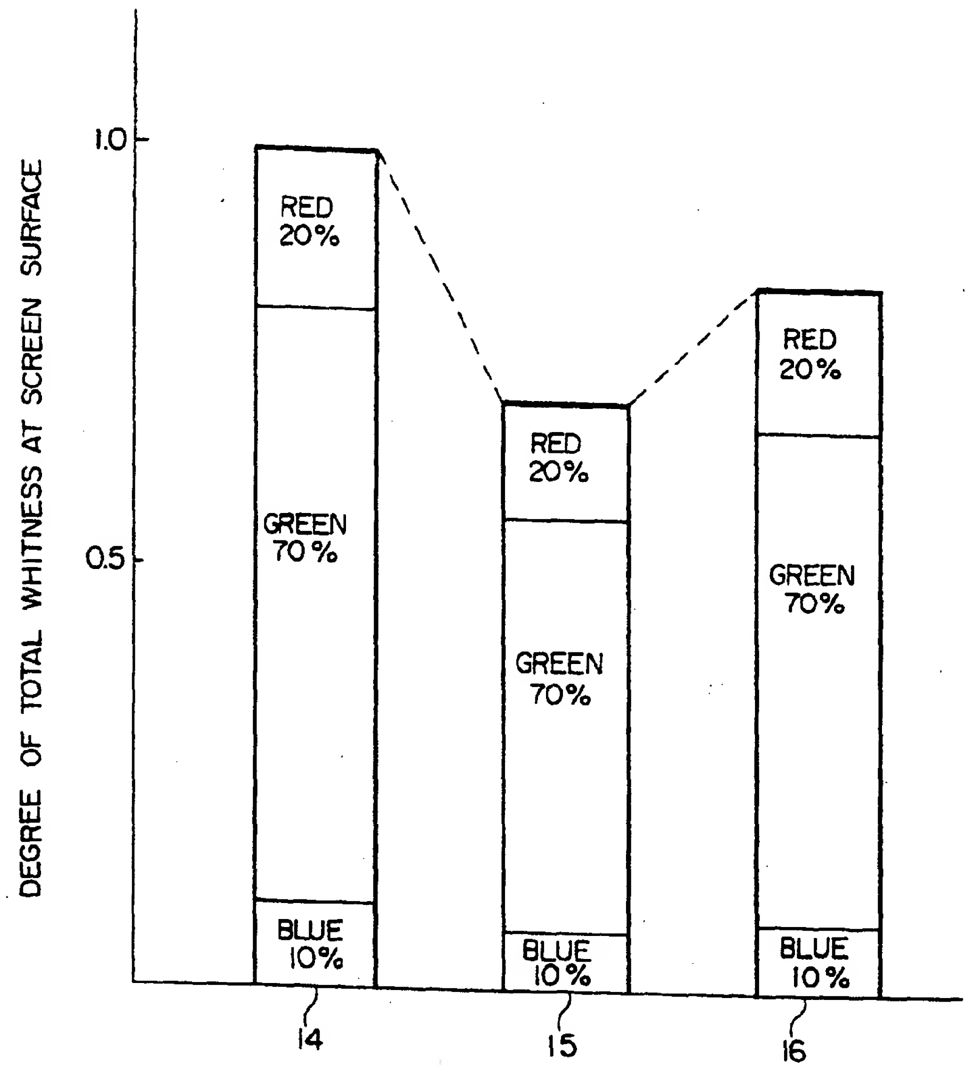

FIG. 4

17: RELATIONSHIP BETWEEN DEGREE OF BRIGHTNESS AND BEAM CURRENT AT GREEN CRT SURFACE

18: RELATIONSHIP BETWEEN DEGREE OF BRIGHTNESS AND BEAM CURRENT AT GREEN CRT SURFACE

19: RELATIONSHIP BETWEEN DEGREE OF BRIGHTNESS AND BEAM CURRENT AT BLUE CRT SURFACE

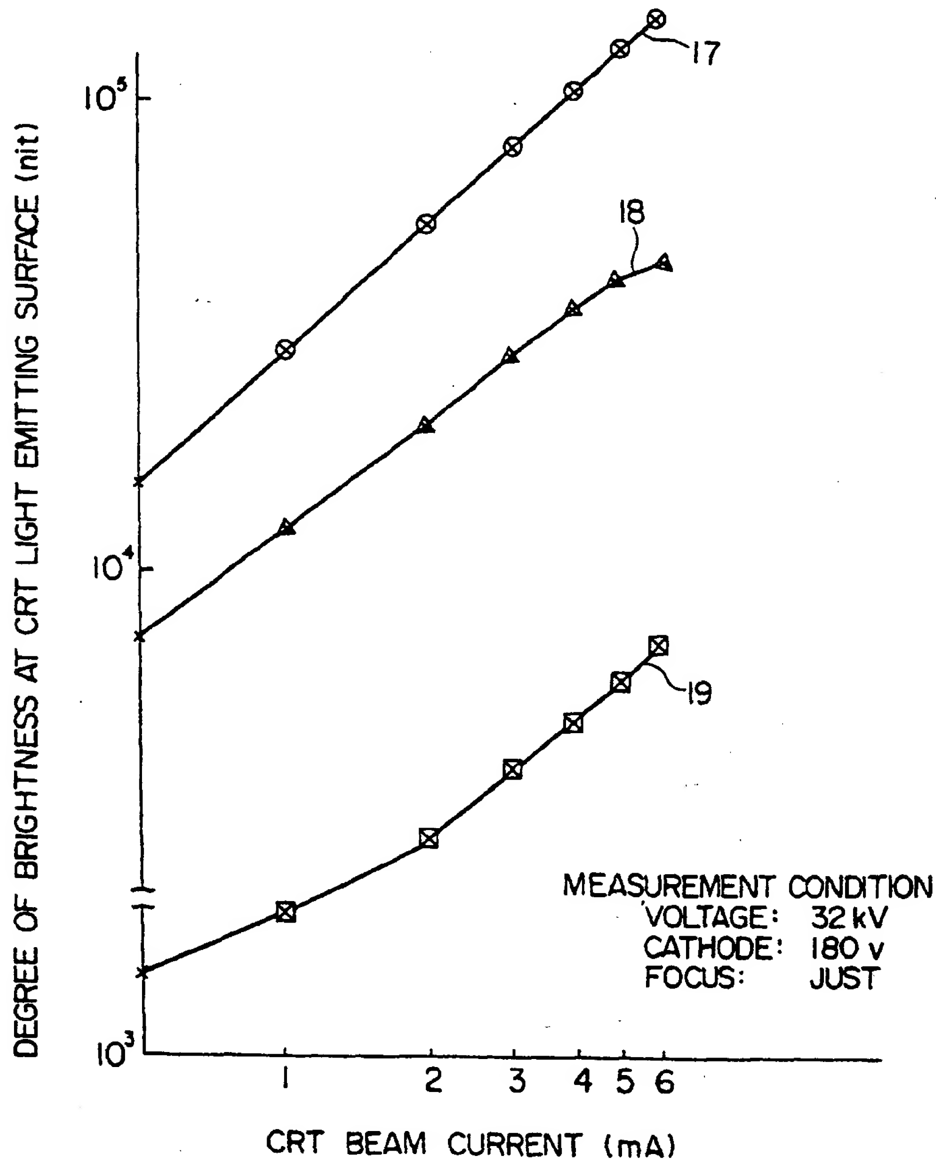

FIG. 5

20: CURRENT RATIOS OF RED, GREEN AND BLUE COLOR CRTS OF CONVENTIONAL TRANSMISSION TYPE SCREEN

21: CURRENT RATIOS OF RED, GREEN AND BLUE COLOR CRTS CAUSED BY 30 % OF UNIFORM VISIBLE LIGHT ABSORBING MATERIAL

22: CURRENT RATIOS OF RED, GREEN AND BLUE COLOR CRTS CAUSED BY SELECTIVE WAVELENGTH ABSORBING MATERIAL

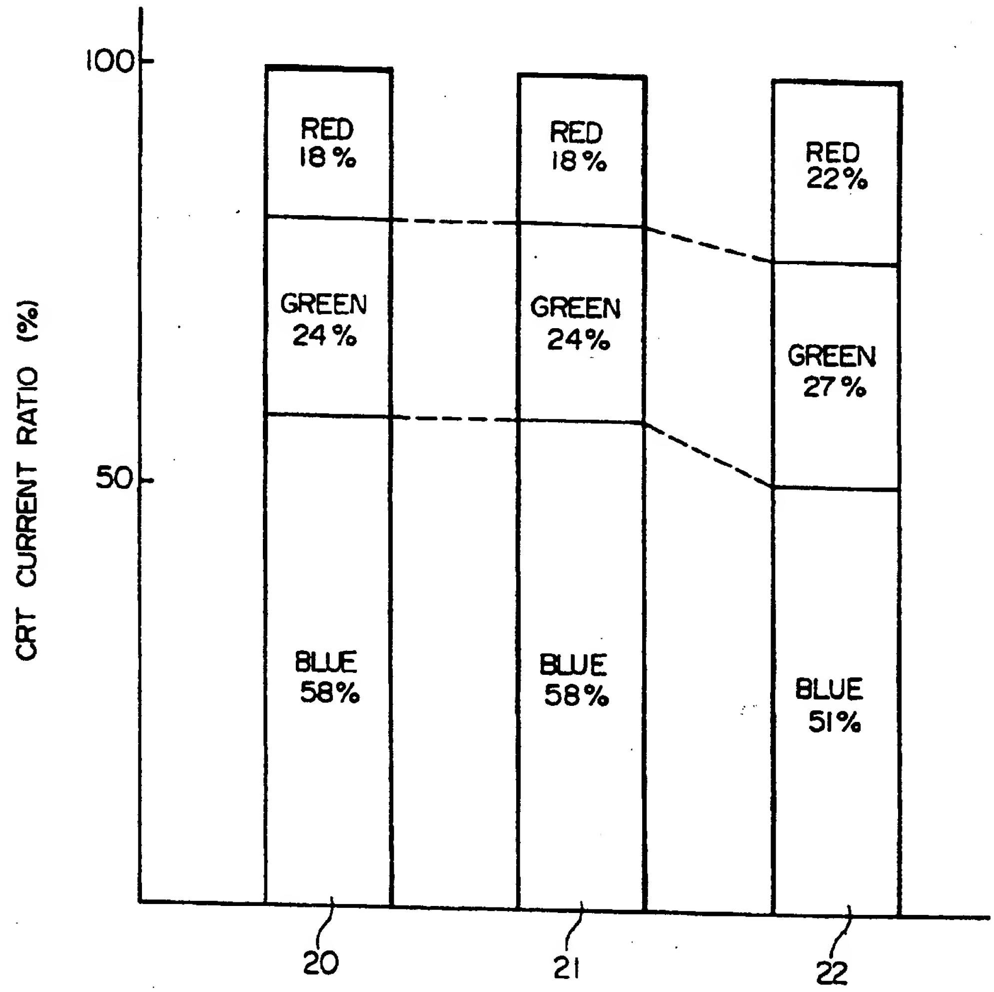

FIG. 6

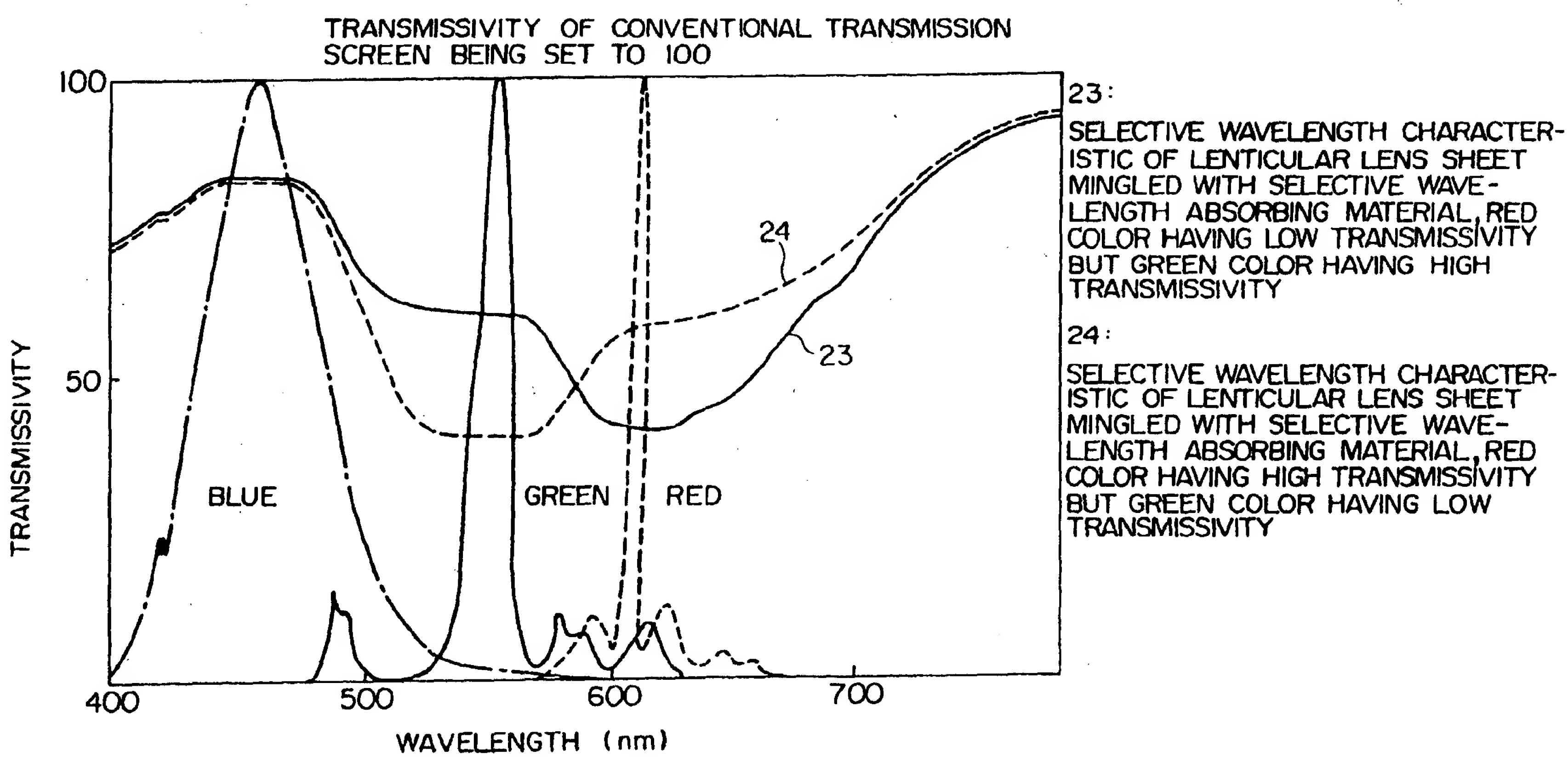
TRANSMISSIVITY OF CONVENTIONAL TRANSMISSION SCREEN BEING SET TO 100
TRANSMISSIVITY
100
50
400
500
600
700
WAVELENGTH (nm)
BLUE
GREEN
RED
23
24
23:
SELECTIVE WAVELENGTH CHARACTERISTIC OF LENTICULAR LENS SHEET MINGLED WITH SELECTIVE WAVELENGTH ABSORBING MATERIAL, RED COLOR HAVING LOW TRANSMISSIVITY BUT GREEN COLOR HAVING HIGH TRANSMISSIVITY
24:
SELECTIVE WAVELENGTH CHARACTERISTIC OF LENTICULAR LENS SHEET MINGLED WITH SELECTIVE WAVELENGTH ABSORBING MATERIAL, RED COLOR HAVING HIGH TRANSMISSIVITY BUT GREEN COLOR HAVING LOW TRANSMISSIVITY

FIG. 7

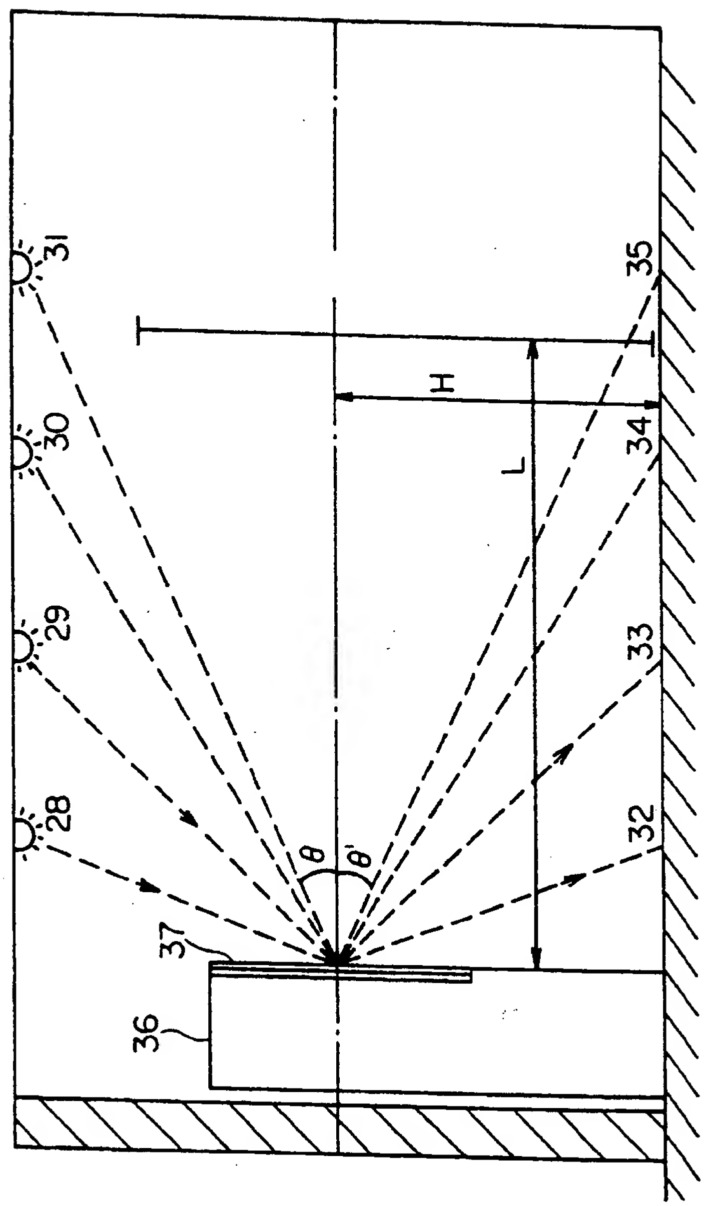

FIG. 8

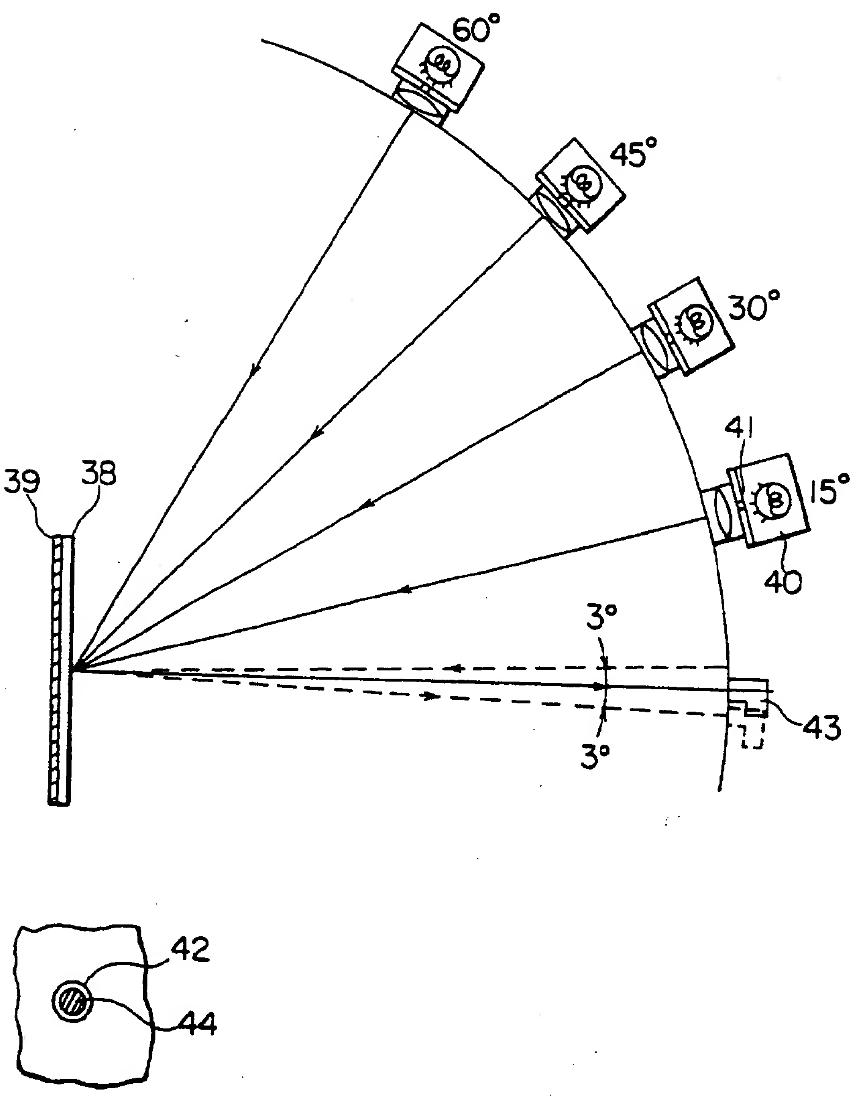

FIG. 9

49: CURVE EXHIBITED BY OUTER SURFACE HAVING CONCAVITIES AND CONVEXITIES

50: CURVE EXHIBITED BY OUTER SURFACE HAVING BLACK STRIPS (BS)

51: CURVE EXHIBITED BY OUTER SURFACE WHICH IS ENTIRELY MIRROR-LIKE

52: CROSSPOINT WHERE INTENTISY OF REFLECTION IS REVERSED

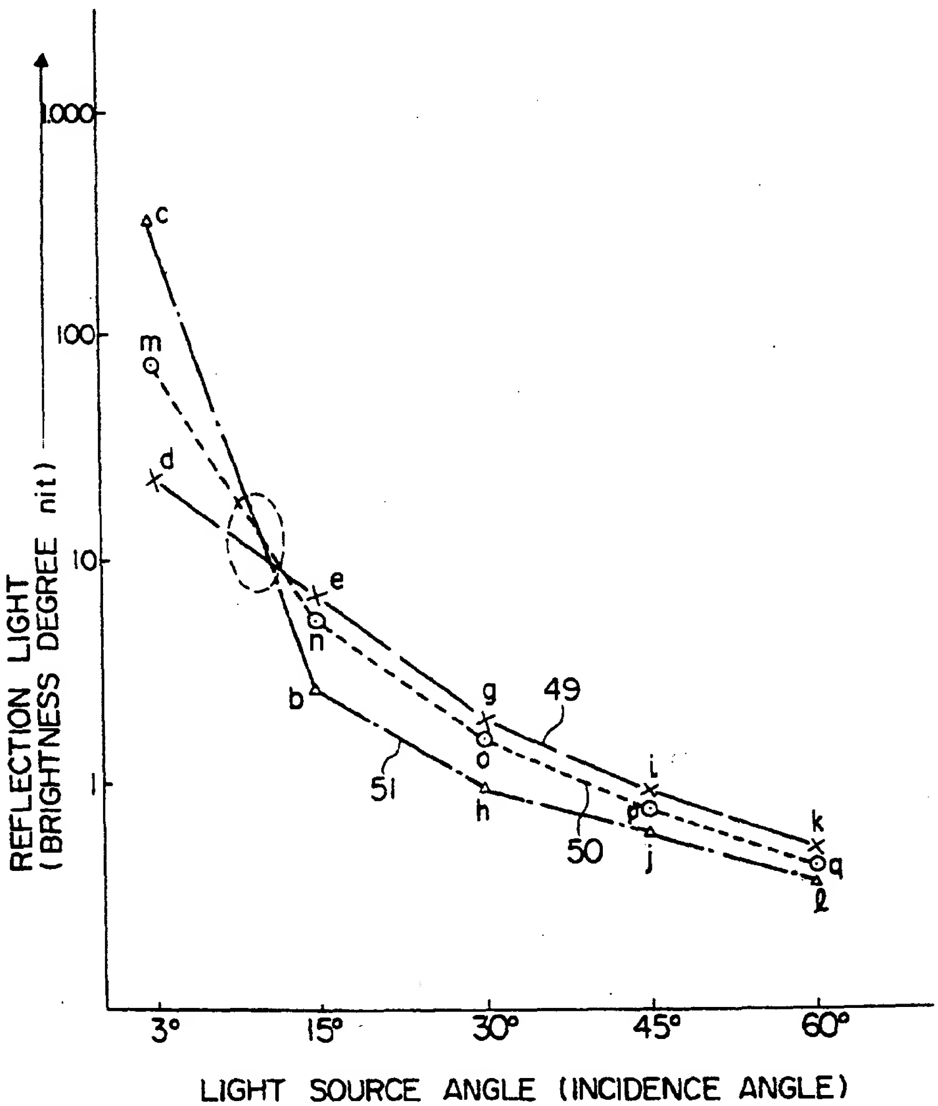

FIG. 10 A

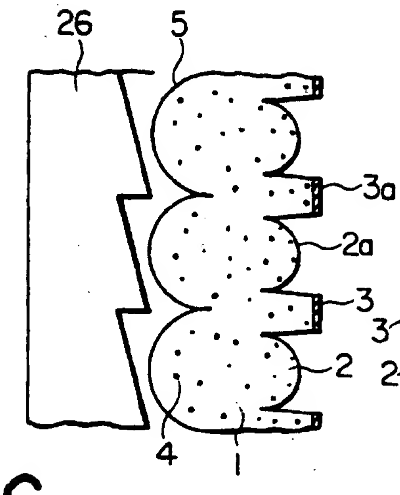

FIG. 10 B

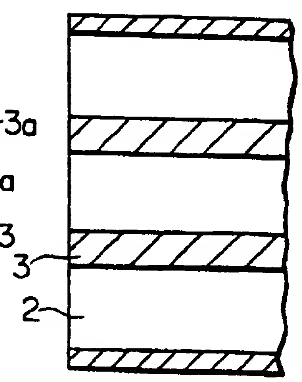

FIG. 10 C

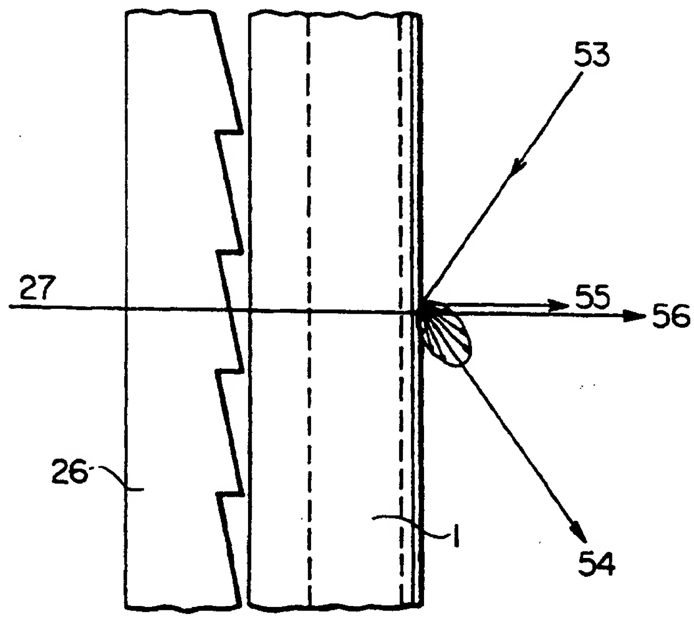

FIG. 11

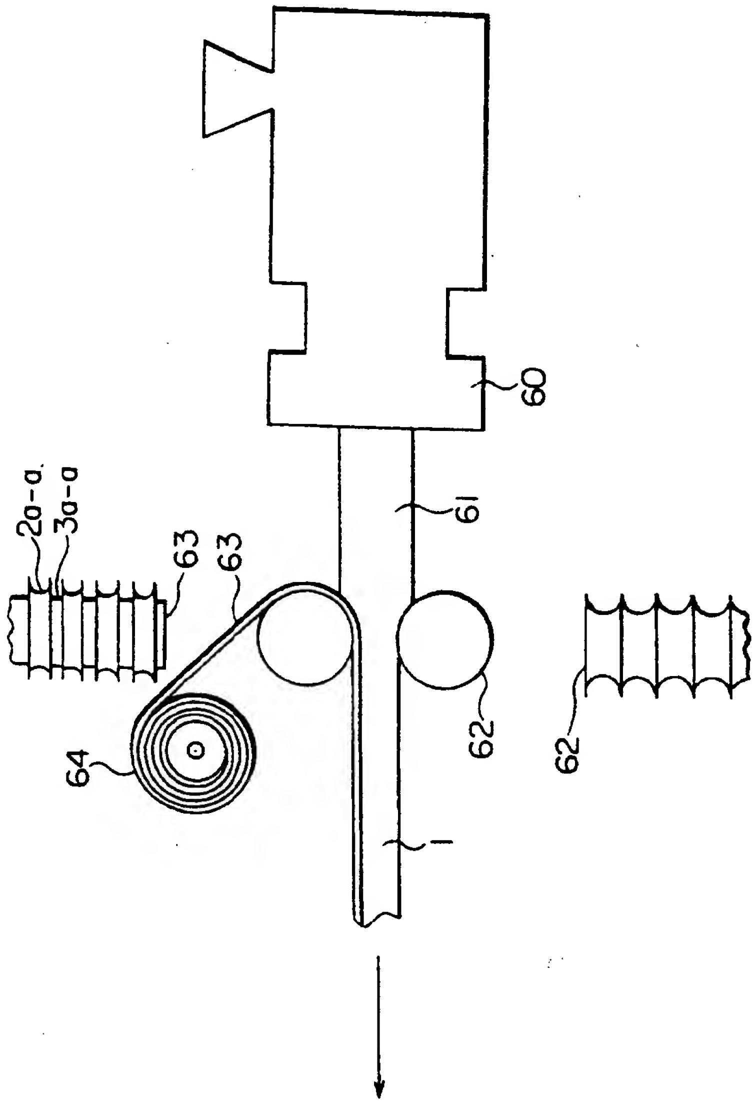

FIG. 12 A

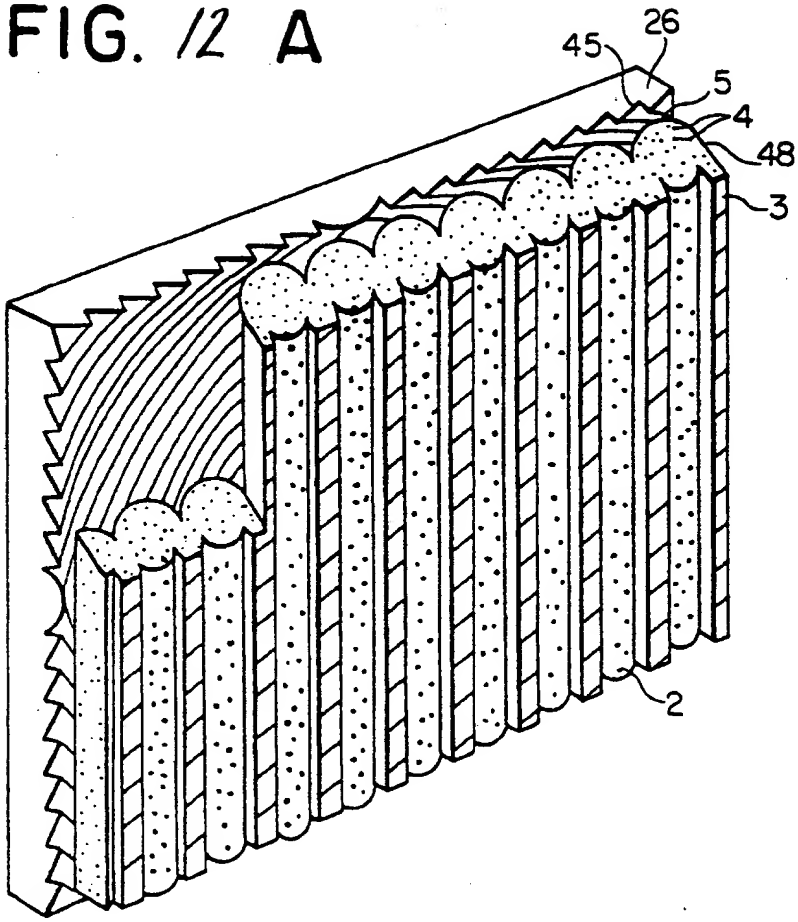

FIG. 12 B